

From: [Daniel Dodd](#)
To: [Zuniga, Mario](#)
Cc: [Dancher, Nathan](#); [Batchelder, Amber](#); [Yannayon, Laura](#); MGiraud@mbard.org; [Johan Van Walsem](#); [Meredith Roberts](#)
Subject: RE: Applicability Determination Questions
Date: Thursday, June 18, 2020 9:42:42 PM
Attachments: [image001.png](#)
[image002.png](#)
[image003.png](#)
[image004.png](#)
[image005.png](#)
[image006.png](#)
[image007.png](#)

Mario, see responses in blue below:-

1. Clarify Purpose of Pilot Demonstration

- a. Is Sierra Energy requesting an applicability determination for a pilot demonstration FastOx Gasification Biorefinery (FastOx Gasifier) that will be converted into a full-time operation?

<< SE: The FastOx Gasification Biorefinery system at Fort Hunter Liggett (FHL), is a demonstration project at a commercially relevant scale, with multiple stakeholders and test and validation goals. Historically, it has been operated in short, 2-week campaigns, up to six (6) campaigns per year. In the future, SE will be increasing the team/staff size and driving it towards more-continuous operations to further define technology, engineering and key economic metrics in support of future commercial projects. The FHL demonstration plant is currently self-funded by Sierra Energy and it is not operated for commercial profit. The plant has sufficient capacity and end-to-end integration to generate data that is fully relevant to future commercial projects with 3rd parties.

- b. Is the applicability determination for a pilot demonstration that is not expected to be modified/ramped-up?

<< SE: See above. We will be increasing the system uptime/hours of continuous operation, but do not foresee increasing the system's 10 metric tonne per day capacity. SE may add redundant small equipment items (such as pumps, blowers etc.) to facilitate increasing the system 'uptime', and SE may consider producing other 'end-products' (such as hydrogen, methanol, ammonia) from the syngas for demonstration, validation and optimization purposes only, not for commercial revenue.

- c. If the FastOx Gasifier will be converted from a pilot demonstration to a full-time operation, how will the process change?

<< SE: As described previously, this project is not a commercial operation. While SE will be driving the uptime/availability of the system upward (to assist with long-term data capture and future system sales), it will not be converted into a commercial 'for-profit' plant.

2. Origin of waste fed to FastOx Gasifier

- a. Is all the waste used in the FastOx Gasifier generated at the Fort Hunter Liggett (and is therefore "institutional waste" (IW))?

<< SE: The system at FHL will be receiving and converting waste materials both generated by/on FHL, and also waste materials generated offsite. The system may also receive and convert non-waste products-of-commerce (for example clean paper products, clean plastics) for certain test, validation and optimization campaigns.

- b. Does the FastOx Gasifier also take in Municipal Solid Waste (MSW) from outside FHL? If so, what are the percentages of MSW and IW that are fed into the FastOx Gasifier?

<< SE: As mentioned above, indeed, materials (waste and non-waste) can be received from outside FHL. Depending on the goals of each specific testing campaign, there may be anywhere from 0 to 100% materials generated onsite at FHL being converted; the balance being materials generated offsite. Materials received from offsite must conform to all conditions of our solid waste facility permit exemption and comply with CA law. Offsite waste materials are processed by a 3rd party waste processor to recover recyclable materials and remove any hazardous materials that are not approved (which subsequently, would be sent to landfill) before being received at FHL. This allows SE to test a broader range of materials, including those from interested commercial partners to verify the technology performance on the actual material of interest for the commercial project.

3. Oxygen levels in reaction zones

- a. Do the multigas analyzer and/or the paramagnetic analyzer measure O₂? Note 2 from your February 28, 2020 email says the combined syngas (from all zones) is sampled and analyzed as it exits the gasifier.

<< SE: Both the multigas analyzer* and the dedicated O₂-only measurement analyzer (using paramagnetic measurement technology) do indeed continuously measure O₂ concentrations from a slipstream of process gas that is removed continuously from the FastOx Gasifier outlet.

*(that contains an Electrochemical detector (ECD) for O₂ measurement, as well as Thermal Conductivity Detector (TCD) for H₂ measurement and Non-Dispersive Infrared (NDIR) sensors for CO, CO₂, CH₄ and C₃H₈ measurement)

- b. The FastOx Gasifier uses a real-time control system. How often is the sampling and analysis completed? E.g. is it once every 15 minutes?

<< SE: The Rockwell Automation system has over 1,400 input-output measurements and parameters being monitored and/or controlled at rates up to 'once per second'. The continuous gas analysis subsystem is reporting changes in gas composition every one (1) second. This subsystem has been designed to 'respond' to (observe) changes in gas composition in less than 30-seconds (from the process change, to it being registered by the gas analyzer (including delays in the gas sampling equipment and the instrument's own inherent 'response time'), to it being reported to the plant controls system and control board operators).

- c. Note 2 mentions the combined syngas is analyzed at the exit of the FastOx Gasifier. How is the O₂ content at each zone measured/determined?

<< SE: The FastOx gasification vessel is a simple, refractory-lined cylinder, and all major gasification reactions take-place within this single vessel, within the bed of waste materials being converted.

The 'zones' that were described previously (in the memo submitted August 2019 and in the February 2020 correspondence) are actually all present mere inches apart within the solid feed bed that maybe only 6ft tall by 3ft in diameter. These idealized zones presented before are not separate reaction chambers as may be the case with other processes. In fact, this is one of the key benefits of updraft gasification technologies; their simplicity and high thermal efficiencies as all reactions are taking place in a single, small volume.

It is not practical to attempt to measure the O₂ concentration within the bed given that these idealized zones do not match precise geometric positions coupled to the harsh conditions with temperatures up to 4000 °F that would melt any sampling device.

Therefore, it is in the cooler region where the syngas is exiting the FastOx gasifier vessel that it is possible to continuously sample the 'Final FastOx Gasifier Syngas' for continuous analysis and process control. The residence time of syngas in the gasifier is on the order of seconds, so any changes occurring in the reaction zones results in very rapid response of the exit gas composition.

4. Details on Polisher process

a. Can you please provide more details regarding the process of the FastOx Polisher?

<< SE: The purpose of the FastOx Polisher is to increase the temperature of the Final FastOx Gasifier Syngas (exiting the FastOx Gasifier vessel, as described above) to break-down condensable hydrocarbon components (for example acetic acid, ethanol, wax etc.) and convert it into additional gaseous syngas components. The FastOx Polisher achieves this by injecting steam, oxygen, and auxiliary fuel under very controlled conditions (see below response to 4)b. below for further details). Not only does this FastOx Polisher unit operation decrease/mitigate these condensable hydrocarbons causing issues with blocking downstream piping and equipment (if they were to cool, condense out and build-up), but it also maximizes the amount of clean, dry syngas for conversion to the final end-products, so the overall system yield/efficiency increases.

b. Are temperature and oxygen content monitored and/or controlled in the polisher process? If so, how?

<< SE: Indeed, it is imperative to monitor the temperature and Polisher-Outlet Syngas composition continuously.

There are five (5) thermocouples on, and inside, this refractory-lined vessel. A slipstream of 'Post-Polisher Syngas' is continuously removed from the exit pipework, conditioned, and sent to a near-identical set-up as described above for the FastOx Gasifier Syngas analysis:-

- One (1) continuous multigas analyzer (with a ECD-TCD-NDIR configuration described above that has the ECD for O₂ analysis)
- One (1) continuous paramagnetic O₂ analyzer.

One important clarification: continuously monitoring the temperatures and more-importantly process gas compositions, ensures that optimum syngas quality is being produced, and therefore the overall system yield and efficiency are both being

maximized. If these parameters were not monitored (and used for process control and optimization), the CO and H2 could decrease and CO2 and H2O could subsequently increase, greatly decreasing the FastOx Biorefinery's end-product yields, at significant detriment to any operating economics required to make a project financially viable. Our entire process is predicated on, and incentivized to, maximize the energy stored in products, versus generating heat as would be the case with an incineration process.

V/R,
DMD



Daniel M. Dodd

Chief Technology Officer

(530) 759-9827 x503 | Cell (916) 215-6416

1222 Research Park Drive, Davis, CA 95618



From: Zuniga, Mario <zuniga.mario@epa.gov>

Sent: Wednesday, June 10, 2020 3:47 PM

To: Daniel Dodd <ddodd@sierraenergy.com>

Cc: Dancher, Nathan <Dancher.Nathan@epa.gov>; Batchelder, Amber <Batchelder.Amber@epa.gov>; Yannayon, Laura <Yannayon.Laura@epa.gov>; MGiraud@mbard.org

Subject: Applicability Determination Questions

Hi Daniel,

Thank you for providing additional requested information for this applicability determination in a timely manner. We are working on your applicability determination and require additional information.

Please answer the following questions in detail.

1. Clarify Purpose of Pilot Demonstration

- a. Is Sierra Energy requesting an applicability determination for a pilot demonstration FastOx Gasification Biorefinery (FastOx Gasifier) that will be converted into a full-time operation?
- b. Is the applicability determination for a pilot demonstration that is not expected to be modified/ramped-up?
- c. If the FastOx Gasifier will be converted from a pilot demonstration to a full-time operation, how will the process change?

2. Origin of waste fed to FastOx Gasifier

- a. Is all the waste used in the FastOx Gasifier generated at the Fort Hunter Liggett (and is therefore "institutional waste" (IW))?

- b. Does the FastOx Gasifier also take in Municipal Solid Waste (MSW) from outside FHL? If so, what are the percentages of MSW and IW that are fed into the FastOx Gasifier?
- 3. Oxygen levels in reaction zones
 - a. Do the multigas analyzer and/or the paramagnetic analyzer measure O₂? Note 2 from your February 28, 2020 email says the combined syngas (from all zones) is sampled and analyzed as it exits the gasifier.
 - b. The FastOx Gasifier uses a real-time control system. How often is the sampling and analysis completed? E.g. is it once every 15 minutes?
 - c. Note 2 mentions the combined syngas is analyzed at the exit of the FastOx Gasifier. How is the O₂ content at each zone measured/determined?
- 4. Details on Polisher process
 - a. Can you please provide more details regarding the process of the FastOx Polisher?
 - b. Are temperature and oxygen content monitored and/or controlled in the polisher process? If so, how?

We are looking into the information you have previously provided and are consulting with expert staff in the region and headquarters. We hope to finalize the applicability determination within a few weeks after your response. We will let you know if we need additional information.

Again, thank you for reaching out to EPA regarding this matter. We appreciate your patience and the additional information you have provided thus far.

Best regards,

Mario Abraham Zuñiga
Air Permits Section (AIR-3-1)
U.S. EPA, Region 9
(415)947-4282